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Health Service. From the data which are being collected in this way it is expected to make an extensive study of the epidemic in New York City. In addition to this, they have undertaken an intensive study of one borough of the city of New York, the borough of Richmond, which includes the whole of Staten Island. This particular borough offers an excellent opportunity for study of this character and will, it is hoped, give a good cross-section view of the epidemic.

Epidemiologic studies have also been undertaken in States surrounding New York City, more especially, New Jersey, New York, Connecticut, Rhode Island, and Massachusetts. Through the cooperation of the State boards of health of these various States, the Public Health Service hopes to obtain data which will give some idea of the relation of outbreaks of the disease in these States to the epidemic in the city of New York. And, moreover, opportunities will doubtless be offered in these States for studies of small localized outbreaks in rural communities. Such outbreaks offer unusually favorable opportunities for this character of work.

DIAGNOSIS OF PLAGUE IN RATS.

THE ADVISABILITY OF MAKING ROUTINE MICROSCOPIC EXAMINATIONS OF RATS, SUPPLEMENTARY TO THE MACROSCOPIC EXAMINATION.

By C. L. WILLIAMS, Passed Assistant Surgeon, United States Public Health Service.

In 1906 the English Plague Commission in India definitely and finally established the relation between rodent and human plague.

Among the many details to which they gave exhaustive study was that of a standard for diagnosing plague in rats. As set forth by these workers the presence of plague infection is variously indicated by certain definite post-mortem signs which may occur singly or in different combinations.

The gross lesions which these investigators considered typical of plague infection in rats were: Subcutaneous injection, pleural effusion, bubo, and granular liver.

They likewise decided that it was the combination of two or more of these signs that made for a provisional diagnosis of plague infection.

Having thoroughly established the naked-eye appearance of acute or subacute plague in rats the commission next made comparative studies as to the relative merits of the macroscopic in contrast to the microscopic method for determining plague rats at necropsy.

For this purpose a definite series of rats was simultaneously examined by two groups of workers, one group making their diagnoses from the naked-eye appearance of the rodent carcass, the other group depending upon the microscopic examination of smears from the spleen for diagnoses. The diagnoses so recorded were subsequently compared.

In doubtful cases or where disagreement arose, diagnosis was determined by animal inoculation.

The commission concluded as follows:

> The results of tests carried out for the purpose of comparison make it manifest that the naked eye is markedly superior to the microscopical method as an aid in diagnosis.[1]

Also they state:

> A review of the analysis leaves no room to doubt that for purposes of diagnosis naked-eye examination by a competent observer is more satisfactory than microscopical examination alone.[2]

They further assert:

> The results clearly show that the omission of the routine microscopical examination of every rat in an investigation conducted on a large scale does not necessarily impair the accuracy of the work.[3]

In view of these conclusions the commission thereafter entirely abandoned routine smear examination, making positive diagnoses in the great majority of cases on the naked-eye appearance of tissues, though resorting to the supplemental aids of examination of smears or animal inoculation or both in cases where they were in doubt.

Methods in Use at Present Time.

Since the English Plague Commission published its report other plague workers have conformed to the commission's views, and in consequence have almost without exception abandoned routine smear examination in the belief that it was a laborious procedure of doubtful value. As far as the writer is aware, the naked-eye appearance of rodents coming to necropsy was relied upon for tentative diagnosis in the plague-eradicative campaign of 1907 in San Francisco; in Seattle, 1907; in Porto Rico, 1912; in Habana, Cuba, 1912; and in New Orleans during the first part of the campaign which began July, 1914.

The Evidence Suggestive of Error in Diagnosis.

In studying the reports of the English Plague Commission and more particularly the reports of plague eradicative campaigns in this country a striking feature observed was the occasional occurrence of a long interval between the discovery of successive plague-infected rats. In the commission's reports these intervals would appear in outlying villages, particularly toward the end of the epizootic.

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[1] Journal of Hygiene, Vol. VII, p. 358.
[2] Journal of Hygiene, Vol. VII, p. 341.
[3] Journal of Hygiene, Vol. VII, p. 342.

In San Francisco (1908) there occurred an interim of nearly three months during which period only one plague rat was caught. In Seattle this sporadicity was quite striking. Three plague-infected rats were captured there on December 28, 1907, two more were discovered during the last week in March, 1908; three more were found in April, three in June, six in July, and the next on September 26. After this there was a lapse of 17 months to February 8, 1910; then another lapse of 17 months to August 25, 1911.

In Porto Rico a conspicuous instance occurred in the town of Caguas. Despite intensive trapping an interval from October 14 to December 9, 1912, occurred between the finding of two infected rats. In New Orleans there occurred in the spring of 1915 an interval, from March 9 to May 6, in which no infected rat was found.

In all of these instances rats were being extensively trapped and all were examined in the laboratory.

In considering the various theories that might account for these irregular occurrences, the possibility of infected rats being missed by the macroscopic method seemed to be a probable factor. Other factors may produce this result, but the occurrence of these periods of intermittency in four different campaigns pointed strongly to a common cause, the most probable cause appearing to be error in diagnosis. This view was strengthened by various fortuitous circumstances which occurred in the New Orleans campaign.

It has been stated by McCoy that all plague workers sooner or later discover, generally by accident, cases of rodent plague in which there may be no macroscopic signs of the disease. The experience of the workers in New Orleans certainly bears out McCoy's statement.

On two separate occasions rats brought in alive but evidently quite sick were found, through the employment of animal inoculation, to be plague infected, though at necropsy they showed no signs of plague. One rat was tested out mainly because 393 fleas were found upon it; the other largely because of its evident symptoms of an acute disease. Several other plague-infected rats had been discovered that showed no signs of the disease, the test guinea pigs being inoculated because the rats had been caught at plague foci.

Doubts of the absolute efficiency of the macroscopic method of diagnosis were still further intensified by the discovery that as our experience broadened there was found an increasing relative and absolute number of infected rats showing at necropsy very slight or indistinct signs, the diagnosis being accomplished only by the inoculation of guinea pigs.

Considering all of this evidence the conclusion seemed obvious that an appreciable number of infected rats was being missed. In consequence it was decided to institute routine examination of smears from all rats. This procedure was commenced October 25, 1915, and has been continued. It has been used as a supplement to the macroscopic examination and does not replace the latter in any way. Smears from the spleen and liver of each rat necropsied were made as a cross check to the naked-eye examination.

Results of Microscopic Examination.

It may be stated that plague infection among rats never reached a high percentage in New Orleans, 0.2 per cent being the maximum. At the beginning of the campaign infected rats were more numerous than later on. From July 1 to November 1, 1914, there were found 191 plague infected among a total of 104,227 rats examined.

In November, 1914, a distinct decrease was noticed and from that date infected rodents progressively declined in numbers, so that from November 1, 1914, to October 25, 1915, among 134,894 rats examined there were found only 66 infected.

In the table are given the results of rat examination from October 25, 1915, to March 15, 1916, during which period there were routine examinations of the smears made from the liver and spleen of all rats, as a supplement to macroscopic examination, the microscopic work being performed by a worker not connected with the routine macroscopic examination of rodents.

Number of rats examined	28, 570
Total number of rats found plague infected	20
Number diagnosed from gross lesions	13
Number diagnosed from smears	7
Per cent diagnosed from smears	35

All diagnoses, whether made from gross appearance of the animal or from the microscopic examination of the smears, were confirmed by animal (guinea pig and white rat) inoculation and recovery of the specific organism, i. e., *Bacillus pestis.*

It will be noted from the table that the smear examination resulted in the detection of seven infected rats (35 per cent) which otherwise would have passed unnoticed. These seven cases at necropsy presented absolutely no abnormality discernible by the naked eye suggestive of plague, and this notwithstanding the fact that they were very carefully reexamined after the microscopist had reported the smears as "suspicious."

It should be understood that in plague work conducted for purposes of investigation only, the discovery of all infected rats is not of the same importance as when eradicative measures are to be employed, provided that no great percentage of rats is missed. This condition, for example, was present in India during the work of the

English Plague Commission. Their work was purely an investigation of conditions and they clearly showed that for their purpose macroscopic examination alone was quite sufficient. It is the employment of eradicative measures and their guidance from laboratory findings that make the discovery of all possible infected rats a matter of importance.

Sanitary Significance of Trustworthy Laboratory Examination.

The function of the laboratory force in a plague-eradicative campaign is to demonstrate the status of the infection, to furnish data by which the extent of the infection may be delineated, to report the course of the epizootic, and to determine the absence of infection when the disease has been eradicated. To accomplish this it works in conjunction with the trapping force, the trappers catching the rats and the laboratory force making the post-mortem examination.

Obviously these duties are important. The detection of the various foci of infection determines concentration of effort at the important points. The success or ineffectiveness of eradicative measures, as the case may be, is indicated by the estimation of the rise or fall of the epizootic. Determination of complete absence of infection marks the close of the campaign and the removal of quarantine.

To perform these duties it is manifestly essential that the laboratory technique be highly efficient. When the discovery of each focus means the application of intensive measures it becomes important that no focus be missed. As the infection wanes and foci become few and scattered the value of finding each one is greatly enhanced. When plague rats have ceased to be found it is clear that the more thorough the methods of diagnosis the earlier it can be said with authority that the disease has been eradicated.

When, therefore, in consideration of these points we may by employing routine examination of smears from all rats discover a notable number of infected rats (35 per cent in our series), we have a means of distinctly increasing the efficiency of the laboratory that is well worth the increased labor involved.

Macroscopic Examination Alone in Early Part of Campaign.

During the early part of an antiplague campaign—that is, from its inception until the number of plague-infected rats distinctly decreases—the macroscopic examination alone is probably sufficient.

It is probable that during the height of an epizootic the vast majority of infected rats show well-marked signs, while toward the end of the epizootic, and particularly when eradicative measures have been employed, the relative and, indeed, the absolute number of infected rats showing slight signs or none, distinctly increases. This belief is based partly on the experiments of the English Plague Commission and partly on our observation in New Orleans, where the percentage of infected rats showing slight or indistinct signs markedly and progressively increased as the epizootic declined.

It is apparent, therefore, that routine smear examination assumes its greatest importance when the epizootic is on the wane, for when infection is prevalent and widespread the missing of a few infected rats is not of the same importance as when at a later date foci have become few and isolated.

Summary.

1. In the presence of an epizootic of plague, macroscopic examination alone for the detection of rodent plague results in appreciable error; the microscopic examination of smears should therefore be employed as a supplement to the naked-eye diagnosis of rodent plague when the epizootic declines.
2. This error is greater toward the end of an epizootic and is of particular importance when eradicative measures are being employed.
3. By routine examination of smears a materially important number of infected rats may be discovered that would otherwise pass undetected.
4. In New Orleans from October 25, 1915, to March 15, 1916, 35 per cent of all infected rats diagnosed in the laboratory showed suspicious organisms in smears as the only evidence suggestive of infection.
5. The value of finding all foci of infection in an eradicative campaign fully justifies the labor and expense of routine smear examination, particularly toward the end of the epizootic.

Conclusion.

For the purpose of preventing any misconception the writer desires to state that he agrees with other authorities that for practical purposes the macroscopic method of diagnosis of rat plague is superior to the microscopic method *if either is to be used singly.*

The workers at New Orleans have placed their main dependence upon the naked-eye appearance of rats in their past laboratory examinations and expect to continue to do so. As a matter of fact they have on many occasions made a diagnosis of rodent plague from gross lesions in cases where the " smear " was negative. Moreover, a considerable number of rats were found to be not plague infected, although suggestive organisms were present in the smears.

Experience will teach most plague workers that the appearance of " suspected " organisms in smears from rodent tissues can be considered only as suggestive and not as absolutely distinctive.

The present note relative to diagnosis of rodent plague is presented therefore with the intention of emphasizing the fact that the macroscopic method of diagnosis has its limitations as well as the microscopic, and that it is advisable to supplement the former by the latter method, placing the greater dependence on the naked-eye appearance and making all possible diagnoses thereby, but nevertheless employing the microscopic examination of "smears" from tissues, as a "second line of defense."

BREAD AS A FOOD.

In the Public Health Reports for April 14, 1916 (p. 935), there appeared an article under the following heading: "Bread as a food," with a subheading, "Changes in its vitamine content and nutritive value with reference to the occurrence of pellagra." The facts set forth as regards pellagra have not been challenged, but as some erroneous inferences concerning the value of white flour and of bread made from it have been drawn from the paper, it appears desirable to submit the following statement:

The paper referred to presented the results of certain of the studies which are being made on pellagra and was designed to demonstrate primarily that when a diet poor in essential food elements aside from cereals was constantly used, it appeared likely that if the carbohydrate element contained a liberal amount of the accessory food substances known to be contained in whole grains, the probability of pellagra developing was less than when the starchy element of food was deficient in these substances.

From the broad view of nutrition, it is very probably immaterial what kind of flour is used in making bread provided that an adequate mixed diet is consumed which will supply sufficient of the essential dietary components outside of the cereals contained in the diet. It may be added that the great majority of the people in this country live on a well-balanced, sufficient, mixed diet.